

## CLAIMS

What is claimed is:

1. A differential phase detection device detecting a differential phase signal from first through fourth signals, the differential phase detection device comprising:

a slicer slicing and digitizing each of the first through fourth signals with respect to a reference level;

a first synthesizer synthesizing the first digitized signal and the third digitized signal to generate a first synthesis signal;

a second synthesizer synthesizing the second digitized signal and the fourth digitized signal to generate a second synthesis signal;

a phase difference detector comparing a phase of the first synthesis signal with a phase of the second synthesis signal to generate a first phase difference signal and a second phase difference signal; and

a matrix circuit determining a difference between the first and second phase difference signals received from the phase difference detector to output the differential phase signal.

2. The differential phase detection device as recited in claim 1, wherein the first and second synthesizers perform a synthesis method comprising one of time averaging, an AND operation, or an OR operation on the first and third digitized signals and the second and fourth digitized signals to generate the first and second synthesis signals, respectively.

3. The differential phase detection device as recited in claim 2, wherein the first and second synthesizers generate the first and second synthesis signals using the same synthesis method.

4. The differential phase detection device as recited in claim 2, further comprising:

an alternating current (AC) coupler removing direct current (DC) components from the first through fourth signals.

5. The differential phase detection device as recited in claim 4, further comprising:

an equalizer amplifying the first through fourth signals or the first through fourth signals from the AC coupler, wherein the equalizer is provided between the AC coupler and the slicer.

6. The differential phase detection device as recited in claim 4, further comprising a phase shifter shifting a phase of an input signal between the slicer and the first and second synthesizers or between the first and second synthesizers and the phase difference detector.

7. The differential phase detection device as recited in claim 1, further comprising:

an alternating current (AC) coupler removing direct current (DC) components from the first through fourth signals.

8. The differential phase detection device as recited in claim 7, further comprising:

an equalizer amplifying the first through fourth signals or the first through fourth signals from the AC coupler, wherein the equalizer is provided between the AC coupler and the slicer.

9. The differential phase detection device as recited in claim 7, further comprising a phase shifter shifting a phase of an input signal between the slicer and the first and second synthesizers or between the first and second synthesizers and the phase difference detector.

10. The differential phase detection device as recited in claim 9, wherein when the phase shifter shifts the phase of the input signal between the slicer and the first and second synthesizers, different time delays are applied to each of the first through fourth digitized signals controlling an offset and balance of the shifted phase of the input signal.

11. The differential phase detection device as recited in claim 1, further comprising a phase shifter shifting a phase of an input signal between the slicer and the first and second synthesizers or between the first and second synthesizers and the phase difference detector.

12. The differential phase detection device as recited in claim 2, further comprising a phase shifter shifting a phase of an input signal between the slicer and the first and second synthesizers or between the first and second synthesizers and the phase difference detector.

13. The differential phase detection device as recited in claim 1, wherein the first phase difference signal corresponds to a phase difference between the first and second synthesis signals when the phase of the first synthesis signal input to a (+) input terminal of the phase difference detector leads the phase of the second synthesis signal.

14. The differential phase detection device as recited in claim 1, wherein the second phase difference signal corresponds to a phase difference between the first and second synthesis signals when the phase of the second synthesis signal input to a (-) input terminal of the phase difference detector leads the phase of the first synthesis signal.

15. The differential phase detection device as recited in claim 1, wherein the matrix circuit performs differential and integration operations on the first and second phase difference signals to output the differential phase signal indicative of a tracking error signal.

16. The differential phase detection device as recited in claim 1, wherein the matrix circuit performs summation and integration operations on the first and second phase difference signals to output the differential phase signal indicative of a tracking error signal.

17. The differential phase detection device as recited in claim 1, further comprising:  
a first phase shifter shifting the phase of the first synthesis signal and disposed between the first synthesizer and one input terminal of the phase difference detector; and  
a second phase shifter shifting the phase of the second synthesis signal and disposed between the second synthesizer and another input terminal of the phase difference detector.

18. The differential phase detection device as recited in claim 1, further comprising:  
a first phase shifter shifting a phase of the first and third digitized signals and disposed between the slicer and an input terminal of the first synthesizer; and

a second phase shifter shifting a phase of the second and fourth digitized signals and disposed between the slicer and an input terminal of the second synthesizer.

19. The differential phase detection device as recited in claim 18, wherein when the first and second phase shifters shift the phase of the first and third digitized signals and the second and fourth digitized signals, respectively, and is disposed between the slicer and the first and second synthesizers, different time delays are applied to each of the first through fourth digitized signals controlling an offset and balance of the shifted phase of the input signal.

20. The differential phase detection device as recited in claim 1, wherein a delay unit is omitted.

21. A differential phase detection device receiving first through fourth detection signals from a photodetector to detect therefrom a differential phase signal, the differential phase detection device comprising:

a slicer slicing and digitizing each of the detection signals with respect to a reference level;

a synthesizer synthesizing the digitized detection signals and generating therefrom synthesis signals;

a phase difference detector comparing phases of the synthesis signals and outputting a first phase difference signal and a second phase difference signal; and

a matrix circuit processing the first and second phase difference signals to output the differential phase signal.

22. The differential phase detection device as recited in claim 21, wherein the synthesizer comprises:

a first synthesizer generating a first one of the synthesis signals; and

a second synthesizer generating a second one of the synthesis signal.

23. The differential phase detection device as recited in claim 22, wherein the first phase difference signal corresponds to a phase difference between the first and second synthesis signals when the phase of the first synthesis signal input to a (+) input terminal of the phase difference detector leads the phase of the second synthesis signal.

24. The differential phase detection device as recited in claim 22, wherein the second phase difference signal corresponds to a phase difference between the first and second synthesis signals when the phase of the second synthesis signal input to a (-) input terminal of the phase difference detector leads the phase of the first synthesis signal.

25. The differential phase detection device as recited in claim 22, wherein the first and second synthesizers perform a synthesis method comprising one of time averaging, an AND operation, or an OR operation on the first and third detection signals and the second and fourth detection signals, respectively, to generate the first and second synthesis signals.

26. The differential phase detection device as recited in claim 21, further comprising a phase shifter shifting a phase of an input signal between the slicer and the first and second synthesizers or between the first and second synthesizers and the phase difference detector.

27. The differential phase detection device as recited in claim 21, wherein a delay unit is omitted.

28. A tracking error signal detection apparatus, comprising:  
a photodetector comprising first through fourth division plates which are disposed counterclockwise or clockwise along directions corresponding to radial and tangential directions of the recording medium, wherein the first and third division plates are positioned in one diagonal direction and the second and fourth division plates are position in another diagonal direction and the first through fourth division plates receive light reflected from a recording medium to generate first through fourth detection signals, respectively; and  
a differential phase detection device detecting a tracking error signal from the first through fourth detection signals output from the photodetector,, the differential phase detection device comprising:

a slicer slicing and digitizing each of the first through fourth detection signals with respect to a reference level,

a first synthesizer synthesizing the first digitized signal and the third digitized signal to generate a first synthesis signal,

a second synthesizer synthesizing the second signal and the fourth signal to generate a second synthesis signal,

a phase difference detector comparing a phase of the first synthesis signal with a phase of the second synthesis signal to generate a first phase difference signal and a second phase difference signal, respectively, and

a matrix circuit processing the first and second phase difference signals received from the phase difference detector to output a tracking error signal.

29. The tracking error signal detection apparatus as recited in claim 28, wherein the matrix circuit performs differential and integration operations on the first and second phase difference signals to output the differential phase signal indicative of the tracking error signal.

30. The tracking error signal detection apparatus as recited in claim 28, wherein the matrix circuit performs summation and integration operations on the first and second phase difference signals to output the differential phase signal indicative of the tracking error signal.

31. The tracking error signal detection apparatus as recited in claim 28, wherein the first and second synthesizers perform a synthesis method comprising time averaging, an AND operation, or an OR operation on the first and third signals and the second and fourth signals, respectively, to generate the first and second synthesis signals, respectively.

32. The tracking error signal detection apparatus as recited in claim 28, further comprising:

an alternating current (AC) coupler removing direct current (DC) components from the first through fourth signals.

33. The tracking error signal detection apparatus as recited in claim 32, further comprising:

an equalizer amplifying the first through fourth signals or the first through fourth signals from the AC coupler, wherein the equalizer is provided between the AC coupler and the slicer.

34. The tracking error signal detection apparatus as recited in claim 31, further comprising:

an alternating current (AC) coupler removing direct current (DC) components from the first through fourth signals.

35. The tracking error signal detection apparatus as recited in claim 34, further comprising:

an equalizer amplifying the first through fourth signals or the first through fourth signals from the AC coupler, wherein the equalizer is provided between the AC coupler and the slicer.

36. The tracking error signal detection apparatus as recited in claim 32, further comprising a phase shifter shifting a phase of an input signal between the slicer and the first and second synthesizers or between the first and second synthesizers and the phase difference detector.

37. The tracking error signal detection apparatus as recited in claim 34, further comprising a phase shifter shifting a phase of an input signal between the slicer and the first and second synthesizers or between the first and second synthesizers and the phase difference detector.

38. The tracking error signal detection apparatus as recited in claim 28, further comprising a phase shifter shifting a phase of an input signal between the slicer and the first and second synthesizers or between the first and second synthesizers and the phase difference detector.

39. The tracking error signal detection apparatus as recited in claim 31, further comprising a phase shifter shifting a phase of an input signal between the slicer and the first and second synthesizers or between the first and second synthesizers and the phase difference detector.

40. The tracking error signal detection apparatus as recited in claim 28, wherein the differential phase detection device lacks a delay unit.